§8. Fabrication and High Power Test of a Forced Air-Cooled Brewster Windows

Shimozuma, T., Ito, S., Takita, Y., Sato, M., Kubo, S., Idei, H., Ohkubo, K., Shirasaka, M., Morimoto, S. (Kanazawa Inst. of Tech.)

High power over 1MW and CW (Continuous Waves) millimeter wave injection is required for electron cyclotron heating in LHD. One of the critical issues is to realize a vacuum barrier window. We have been developing a forced air-cooled Brewster window for this purpose. So far we fabricated a $120 \times 320\text{mm}^2$, 2.53mm thickness racetrack disk of a low loss tangent silicon nitride composite (SN-287 [1]) for a 0.5MW CW window. In 1998 we designed and assembled a prototype Brewster window using usual silicon nitride (SN-220 Kyocera) to check the structure of brazing and welding, because the material has very low thermal expansion coefficient. On the basis of this experience of the prototype window, we fabricated a real Brewster window using low loss silicon nitride disk (SN-287). Figure 1 shows a photograph of the real window brazed and welded with a stainless steel flange. The circumference of the racetrack disk can be water-cooled. An assembled Brewster window is shown in Fig. 2. In this case the outlet section was not welded, because it is easy to observe the disk temperature during high power transmission test without outlet section.

Two kinds of air-cooling nozzle sections are prepared. One is a manifold type like as used for simulation experiments using an electrically heated film resistor. Another is an output corrugated waveguide with hole-drilled wall. Both types have been tested and assessed for the simulation experiments.

High power transmission test was conducted and performed through the assembled Brewster window. Figure 3 shows a setup for the testing. At first we examined a direction of polarization of an incident millimeter wave by using a wire grid. In the high power test output power from the window is guided into an MOU (Matching Optics Unit) which consists of two focusing mirrors and an RF shielding box. The RF beam is focused into a water dummy load and estimated its power calorimetrically. The temperature of the window disk can be monitored through a port of the MOU. The temperature measurement was performed by an IR camera. With edge water-cooling and forced gas-cooling, a temperature increase of about 60 degree C was observed during 58kW, 30sec. transmission. Detailed analysis of the experimental data is now being proceeded.

References
1) T. Shimozuma, S. Morimoto, M. Sato, et al., Int. J. Infrared and Millim. Waves, 18(1997)1479.

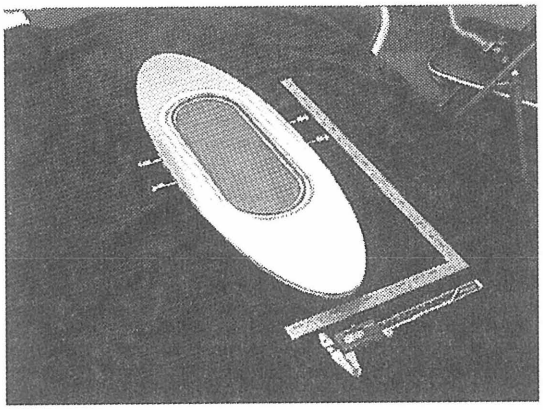

Fig. 1: Low loss silicon nitride disk welded with stainless flange

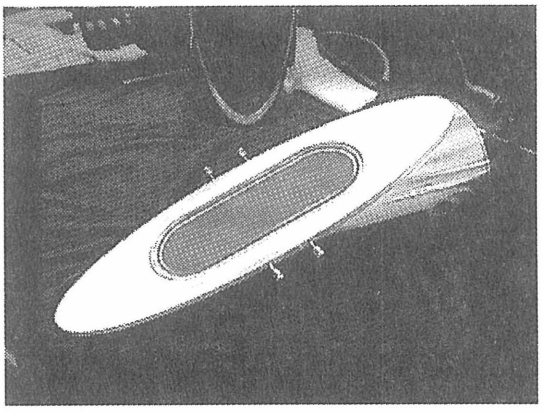

Fig. 2: Assembled Brewster window with an input corrugated waveguidw section

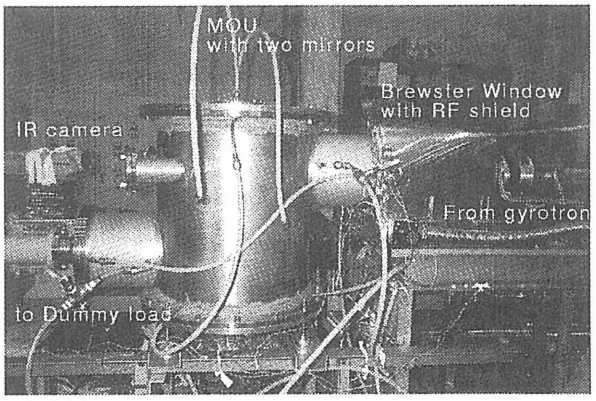

Fig. 3: A set-up for high power transmission test